A CONTRIBUTION TO THE MESOPHYTIC FLORA OF SOUTH AUSTRALIA

(Springfield and Leigh Creek)

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[Read 10 July 1969]

SUMMARY

An introductory description of the macroflora of the Springfield Triassic Basin and the analysis of its age are given. The following palaeobotanical divisions are represented: Ginkgophyta, Arthrophyta, Pteridospermophyta, also Gymnospermous seeds and Incertae sedis.

INTRODUCTION

In 1957 leaf impressions of Triassic age were found by students of the University of Adelaide under the leadership of Dr. Kleeman, approximately 46 km north of Quorn in the Flinders Ranges of South Australia. These impressions were identified by Ludbrook (1961) as *Dicroidium feistmanteli* (Johnston) and fresh-water molluscs *Unio* and *Protovirgus* were described by Ludbrook from the same source. In 1958 and 1959 comprehensive drilling in search of coal was carried out at Springfield by the South Australian Department of Mines, but the project was abandoned as only thin seams of coal were discovered.

In 1965 the writer examined fossil plant specimens from Springfield lodged with the University of Adelaide, which prompted the present investigations.

METHOD

The Springfield Triassic Basin (Lat. 37° 07′ S, Long. 138° 25′ E) is situated some 375 km north of Adelaide in an undulating section of the Flinders Ranges, bordering the Willochra plain.* The roads from Adelaide are bituminized, with the exception of the last 15 km which are bush tracks. Due to some hazardous creek beds in the latter section, the locality should be visited during the dry season, using a four-wheel-drive vehicle.

The specimens, unless specifically stated otherwise, were collected by the writer during the years 1965 to 1969, on the central mesa of the Springfield Basin, Section 48 Hundred of Cudla Mudla. They were picked up from the surface, or dug out from a depth of up to 20 cm. Where a specimen is mentioned with its counterpart, the original rock was split open by the writer on the site.

Descriptions are based on hand lens observations, microscopic investigations have not been carried out.

All described specimens have been listed and deposited with The South Australian Museum, Adelaide. The numbers with the prefix P, shown in brackets in the text, are the Museum registration numbers.

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* For locality map see *Trans. R. Soc. S. Aust.* 84: 140, for geological map see Willochra Geological Survey sheet, Department of Mines, Adelaide.

Division GINKGOPHYTA

Family GINKGOACEAE

Ginkgo antarctica (Saporta)

(Plate 1, figs. 1-2)

Fig. 1 Hypotype (P14117)

Description: Portion of a *Ginkgo* leaf, only partly preserved. The centre part of the lamina has been preserved, the outer margin is missing. The base of the lamina has been laying exposed and has weathered. The width of the upper part of the lamina is 40 mm, the width of the lower part 8 mm. The available length is 18 mm, the length of the full lamina is estimated at 30-40 mm (without petiole). The lamina is split into four lanceolate segments, curved outwards. The segments are of different width, average width at the centre line is 5-10 mm. The veins are clearly marked, dichotomously branching, and 1 mm apart.

Fig. 2 Hypotype (P14118)

Description: A small *Ginkgo* leaf, lamina only (spur shoot leaf?). The lamina is triangular in shape, width at the margin 25 mm, length 30 mm. Slightly off centre to the right is a pinnule (*Dicroidium*) overlying the margin. Slightly off centre to the left of the margin the lamina is lobed (torn?), the width of the lobe at the margin is 2½ mm, the depth 4 mm. The lobe appears to have been torn during the embedding process. The outer margin at the left side appears to be damaged. The lamina near the base is partly covered with the overlying material. A petiole cannot be distinguished. The veins in the lamina are numerous, radially arranged, and repeatedly branch dichotomously. They are scarcely visible to the naked eye. Four veins are located in the width of 1 mm. The imprint of the veins is clear toward the margin, however it fades out near the base through imperfect impression.

Division ARTHROPHYTA

Class EQUISETALES

(Plate 1, figs. 3-7)

The findings so far are only fragmentary, but there is enough evidence to claim that this class was present. The details, however, are insufficient to put the plants into a particular genus or species, as only parts of stems have been found and no trace of complete leaves. Leaf fragments which could be assigned to Equisetales differ from those described from other Triassic localities.

Fig. 3 (P14119)

Stem only, length of impression 68 mm, width 20 mm. The stem shows 5 longitudinal flattened ridges. Nodes and striation are not visible.

Fig. 4 (P14120)

Stem with one node, length 63 mm, width 16 mm, width at the node 18 mm. The impression is flattened and at the top end the diameter is 1 mm. The stem appears to be loose from the surrounding bed. It is distinctly striate, showing 7 faintly distinguishable longitudinal ridges, bulging out at the node, which is partly damaged, so that the base of the leaf sheath is not visible.

Fig. 5 (P14121)

Faint impressions with one node. Length 45 mm, width 8-10 mm. The node is located at approximately the centre of the stem. 7 longitudinal ridges are faintly visible.

Fig. 6 (P14122)

Stem with two nodes. Length 30 mm, width 9 mm. The internode is 15 mm long. The stem appears to be twisted into an angle of 30°. The imprint is distinctly ribbed, the ribs running parallel, occasionally branching dichotomously. 22 ribs are located on the stem.

Fig. 7 (P14146)

Stem with two nodes and three internodes, length 40 mm, width 7 mm. The internodes are 14 mm long. Five ribs are distinguishable on the centre internode. The specimen shows five leaf scars at the nodes, each ½ mm in diameter.

Division PTERIDOSPERMOPHYTA

Family CORYSTOSPERMACEAE Thomas 1933

Genus DICRODIUM Gothan 1914

Dicroidium odontopteroides (Morris) Gothan

(Plate 1, fig. 8; plate 3, figs. 16 and 17)

In the description of the following specimens the name *D. odontopteroides* has been used in a broad sense to include plant remains whose taxonomy cannot be better clarified due to imperfect preservation.

Plate 1, fig. 8 (P14123)

Partly preserved lamina of a frond, with a well preserved cuticle on the rachis and on part of the pinnules. Imprint of a frond with the rachis forked dichotomously. Full length of the rachis 68 mm, width near the base 1½ mm, width near dichotomy 2 mm. Width of the rachis above the forking 1 mm, length of the rachis unforked 43 mm. The rachis is covered with an uneven surface created by raised blisters, 30 blisters in the length of 10 mm. The pinnules are located on both sides of the rachis, at a close set. The shape varies from lanceolate obtuse, to semicircular. All pinnules are attached to the base in full width. The venation is odontopteroid, some pinnules show a centre vein, the latter following half way through the pinnule. Certain secondary veins branch dichotomously approximately half way to the margin.

Plate 3, fig. 16 (P14131)

Description: Imprint of a fernlike dichotomous frond, length 80 mm. The two pinnae branch at an acute angle 25 mm from the basal end of the frond. The pinnules are located at a close set and are attached to the base in full width. Their margin is entire, the shape varies from elongate with an ovate apex, to semicircular. The elongate pinnules are located toward the apices of the pinnae. They possess a midrib which extends 2/3 of the way toward the margin before it opens out. The secondary veins form an acute angle with the midrib. The semicircular pinnules are dominant near the base of the frond and at the inner side of the pinnae toward the dichotomy, the venation is odontopteroid. Length of pinnules 4-9 mm. The secondary veins show dichotomous branching.

Remarks: This specimen resembles the Queensland specimen described by Walkom (1917) under *D. lancifolia*.

Plate 3, fig. 17 (P14132)

Description: Part of frond with a seed-like structure attached to the rachis (poorly preserved). Several secondary branches arise from the main rachis, their length being partly obscured, but at least 22 mm. The visible length of the rachis is 90 mm, width at the base 2 mm, width near the apex 1 mm. The rachis bends

slightly into an arc. Pinnules are born on the secondary branches, and also on the main rachis, their venation is odontopteroid, but only faintly visible. A seedlike structure arises 55 mm from the base on the main rachis. The structure is pear-shaped, its surface is somewhat coarser than the underlying grey argillite. It appears to possess a short pedicel and to arise in the angle between the main rachis and a secondary branch. The seed(?) is raised 2 mm above the underlying material. (On the counterpart it creates a respectively deep imprint.) The full length of the seed is 13 mm, width of the widest part near the apex 7 mm. The pedicel of the seedlike structure appears to continue as a 1 mm wide ridge almost to the apex of the seed.

Division Pteridospermophyta

Family CORYSTOSPERMACEAE Thomas 1933

Genus Dicroidium Gothan 1914

Dicroidium feistmanteli (Johnston) 1895 Gothan 1914

(Plate 2, figs. 9-11)

Remarks: This genus, which gives the name to an epoch of the Mesozoic flora, has been described by many authors, and occurs in several places of the Gondwanaland area. In the descriptions, the recommendation of Walkom (1915-1919) has been adopted, thus the species is defined as follows:

Description: Frond bipinnate, venation odontopteroid.

Material:

	Hypotype No. (P14124) Fig. 9	Hypotype No. (P14125) Fig. 10	Hypotype No. (P14126) Fig. 11
Fragments:	1	1	3
length:	60 mm	approx. 115 mm	70 mm
width:	40 mm	180 mm	50 mm
Width of rachis (widest part near base):	2 mm	5 mm	2 mm
Pinnules			
width:	5 mm	7 mm	3 mm
length:	6 mm	10 mm	5 mm
Shape of pinnules:	semicircular to narrow elongate	semicircular	semicircular to narrow elongate
Attachment of pinnules to base:	full width	full width	full width
Angle of pinnules to rachis:	90°	90°	45°-90°

Division Pteridospermophyta

Family CORYSTOSPERMACEAE Thomas 1933

Genus Dicroidium Gothan 1914

Dicroidium acuta (Walkom) 1917

(Plate 2, fig. 12)

Description: The part of a frond is 40 mm in length, and divides dichotomously into two pinnae at about the middle of the impression. The rachis is 2 mm wide at the base, and is striate in places. The pinnules are spaced about 1½ mm apart, are 11 mm long, 3 mm wide at the base, tapering into an acute tip, and are attached by the whole base, joined by a narrow lamina along the rachis. The venation is alethopteroid. The secondary veins make an angle of about 30° to the midrib, which persists to the tip.

Material: The original is specimen No. F 332 in the Queensland Geological Survey Collection, and was found in the Ipswich Series in Queensland (Walkom 1917).

Hypotype (P14127) fig. 12 appears to be similar in all aspects to the original specimen.

Division PTERIDOSPERMOPHYTA

Family CORYSTOSPERMACEAE

Genus XYLOPTERIS (Carruthers) 1872 Frenguelli 1943

Xylopteris elongata (Carruthers) 1903

(Plate 2, figs. 13-15)

Description: The available length of the frond is 50 mm. The dichotomous branching starts 15 mm from the basal end. The width of the branches is 1·5 mm. The width of the pinnae is 1 mm, their length is somewhat obscure, however, a minimum of 25 mm is visible. The strong single medium vein on all parts on the imprint is distinct.

Material: Hypotype (P14128) fig. 13.
Hypotypes (P14129) fig. 14 and (P14130) fig. 15.

GYMNOSPERMOUS seeds

(Plate 3, figs. 18-21)

Fig. 18 (P14133)
Fig. 19 (P14134)
Fig. 20 (P14135)
Fig. 21 (P14136) This specimen was found in close proximity to the impressions of *Dicroidium feistmanteli* (Johnston), in the overburden at the coalfields of Leigh Creek in December 1967.

Division GINKGOPHYTA

Family GINKGOACEAE (?)

Genus PSYGMOPHYLLUM Schimper 1870

Psygmophyllum cf. etheridgei Arber

(Plate 4, figs. 22-24)

Several specimens have been collected by the writer at the Leigh Creek Coalfield, thus showing the abundance of the genus *Psygmophyllum* at the locality. The fragments described give an indication of the size of the lamina of the plants bearing these leaves.

All specimens were collected in December 1967 from the overburden of the Telford Open Cut (Leigh Creek Coalfield).

Fig. 22 (P14137)

The imperfect imprint of the lamina is 14 cm in length, its greatest width is 9 cm. The full length of the lamina is estimated at 19-20 cm. The veins are 1 mm apart. The distal end and the base of the lamina are not preserved.

Fig. 23 (P14138)

Part of a lamina, size: 70 mm x 45 mm. The veins are 1 mm apart and branch dichotomously. The apex of the lamina appears to be torn.

Fig. 24 (P14139)

Part of a lamina, length 12 cm, visible width 4 cm. The parallel veins are clearly marked, 1 mm apart, and show dichotomous branching.

Family INCERTAE SEDIS

Genus TAENIOPTERIS Brongniart 1828

Taeniopteris cf. dunstani Walkom 1917

(Plate 4, figs. 25-26)

Fig. 25 (P14140), fig. 26 (P14141)

Description: Part of frond upper surface. The impression appears to be the part near the apex. It measures 28 mm in length. The average width is 12 mm. The apex appears to be acute, the width near the apex is 7 mm. A strong midrib is visible. The veins are simple and arise at an angle of approximately 70° from the midrib, sometimes they are forked, and occasionally two adjacent veins join before reaching the margin. About 22 veins are located in a distance of 1 cm. A marginal vein is visible.

Family INCERTAE SEDIS

Genus TAENIOPTERIS Brongniart 1828

Taeniopteris spatulata McClelland 1850

(Plate 4, figs. 27-30)

Fig. 28

Description: Part of frond, narrow, slightly lanceolate, the length is 80 mm. The base and distal end are missing, the total length of the frond is unknown. The midrib is prominent and longitudinally striate, its width is 1 mm. The width of the frond at the basal end is 8 mm, at the distal end 9 mm. The veins branch from the midrib at approximately right angle, occasionally they branch anywhere between midrib and margin. There are 10-12 veins located in a length of 5 mm.

Material: Hypotypes (P14142) fig. 28, (P14143) fig. 27, (P14144) fig. 29, (P14145) fig. 30.

CONCLUSION

Ludbrook (1961) does not give the epoch of the Triassic Basin of Springfield, while Brown, Campbell, and Crook (1968) ascribe it to (?)Lower Triassic. The analysis of its macroflora suggests that these deposits were laid down during approximately the Upper Triassic age.

Du Toit (1954) remarks that the *Thinnfeldia* (*Dicroidium*) flora is typical of the Upper Triassic (Rhaetic) in the Cape Natal region (South Africa), and that these Molteno beds have a surprising similarity to the Upper Triassic flora of Ipswich (Queensland), and to the Rhaetic flora of India, Argentina, New South Wales and Tasmania. This similarity is present also in the macrofossils collected from the Springfield Triassic Basin described in this paper. The genus *Ginkgo* has been recorded from the Upper Triassic in the Ipswich series (Walkom 1917). *Taeniopteris* and *Xylopteris* are considered to be Upper Triassic (Seward 1963, Walkom 1917-1919), while Townrow (1967) considers *Dicroidium* and *Xylopteris* to be Middle to Upper Triassic.

The descriptions of the macrofossils of Leigh Creek, based on the "Sweet" collection revised in 1926 by Chapman and Cookson, also show a resemblance to the Springfield fossils.

The Springfield flora is an impoverished fragment of the floras from the localities mentioned above. It does not offer any new information on which the dating of these floras can be improved, but its similarity to them shows that they are of about the same age, that is approximately Upper Triassic.

ACKNOWLEDGEMENTS

I wish to thank the management of Springfield Proprietors, Cradock, for permission to collect fossils on their property. My appreciation goes to Mr. A. Drummond who accompanied me on most of my collection trips. Dr. N. H. Ludbrook kindly advised me on the preparation of the manuscript. For assistance with the secretarial work my thanks to Clr. Mrs. V. Moss, B.A., and Miss J. Rowland. The photographs were taken by Mr. R. V. Leeton, Flinders Park.

REFERENCES

ANDREWS, HENRY N. JR., 1947. "Ancient plants and the World they lived in." (Ithaca, New York.)

ANDREWS, HENRY N. JR, 1967. "Studies in Paleobotany." (John Wiley and Sons, Inc., New York.)

ARNOLD, CHESTER A., 1947. "An Introduction to Paleobotany." 1st ed. (McGraw-Hill Book Co., Inc., New York.)

BARNARD, P. D. W., 1965. The geology of the Upper Djadjerud and Lar Valleys (North Iran). II Palaeontology. *Riv ital. Paleont. Stratigr.* **71**: 1123-1168.

BONETTI, M., 1966. Consideraciones sobre algunos representantes de la familia "Corystospermaceae". *Ameghiniana* IV, (**10**): 389-395.

BROWN, D. A., CAMPBELL, K. S. W., CROOK, K. A. W., 1968. "The Geological Evolution of Australia and New Zealand." (Permagon Press, Oxford.) pp. 226, 229.

CHAPMAN, FREDK., and COOKSON, ISABEL C., 1926. A revision of the "Sweet" collection of triassic plant remains from Leigh's Creek, South Australia. *Trans R. Soc. S. Aust.* L: 163-178.

DELEVORYAS, THEODORE, 1963. "Morphology and Evolution of Fossil Plants." (Holt, New York.)

DU TOIT, ALEX., 1954. "The Geology of South Africa." 3rd ed. (Oliver & Boyd, London.)

HARRIS, THOMAS MAXWELL, 1961. "The Yorkshire Jurassic Flora." Vol. 1. Thallophyta-Pteridophyta. (British Museum, Natural History, London.)

JACOB, K., and JACOB, C., 1950. A preliminary account of the structure of the cuticle of *Dicroidium* (*Thinnfeldia*) fronds from the Mesozoic of Australia. *Proc. natn. Inst. Sci. India* **16**.

JOHNSON, W., 1960. Exploration for coal, Springfield Basin. *Rep. geol. Surv. S. Aust.*, **16**.

LUDBROOK, N. H., 1961. Mesozoic Non-Marine Mollusca from the North of South Australia. *Trans. R. Soc. S. Aust.* **84**: 139-147.

PARKIN, L. W., 1953. The Leigh Creek Coalfields. *Bull. geol. Surv. S. Aust.* **31**.

PLUMB, T. W. ed., 1966. Atlas of Australian resources. Second Series. Geology. 2nd ed. (Department of National Development. Canberra.)

SCAGEL, R. F. *et al.*, 1965. "An Evolutionary Survey of the Plant Kingdom." (Blackie, London.)

SEWARD, A. C., 1963. "Fossil Plants." Vols. 1-4. (Hafner Publishing Co., New York.)

SPORNE, K. R., 1965. "The Morphology of Gymnosperms." (Hutchinson University Library, London.)

THOMAS, H. H., 1933. Mesozoic Pteridosperms. *Phil. Trans. R. Soc.* B. **222**: 193-265.

TOWNROW, J. A., 1967. Fossil plants from Allan and Carapace Nunataks, and from the Upper Mill and Shackleton Glaciers, Antarctica. *N.Z.Jl. Geol. Geophys.* **10**: 456-473.

WALKOM, A. B., 1915-1919. Mesozoic Floras of Queensland. Pts. I-IV. *Publs. geol. Surv. Qd.* 252, 257, 259, 262, 263.

EXPLANATION OF PLATES

Plate 1.

Fig. 1 *Ginkgo antarctica* Hypotype (P14117) x 1·5.
Fig. 2 *Ginkgo antarctica* (spur shoot leaf?) Hypotype (P14118) x 1·5.
Fig. 3 Equisetales stem showing 5 longitudinal flattened ridges. (P14119) x 1.
Fig. 4 Equisetales stem with one node. (P14120) x 1.
Fig. 5 Equisetales stem with one node. (P14121) x 1·5.
Fig. 6 Equisetales stem with two nodes. (P14122) x 2.
Fig. 7 Equisetales stem showing leaf scars at the nodes. (P14146) x 1·5.
Fig. 8 *Dicroidium odontopteroides* showing raised blisters on the rachis. (P14123) x 1.

Plate 2.

Fig. 9 *Dicroidium feistmanteli* Hypotype (P14124) x 1.
Fig. 10 *Dicroidium feistmanteli* showing large frond. Hypotype (P14125) x 0·25.
Fig. 11 *Dicroidium feistmanteli* Hypotype (P14126) x 0·5.
Fig. 12 *Dicroidium acuta* Hypotype (P14127) x 2.
Fig. 13 *Xylopteris elongata* Hypotype (P14128) x 1.
Fig. 14 *Xylopteris elongata* Hypotype (P14129) x 1.
Fig. 15 *Xylopteris elongata* Hypotype (P14130) x 1.

Plate 3.

Fig. 16 *Dicroidium odontopteroides* (P14131) x 1.
Fig. 17 *Dicroidium odontopteroides* with seed-like structure attached to the rachis. (P14132) x 0·8.
Fig. 18 Gymnospermous seed (P14133) x 1.
Fig. 19 Gymnospermous seed with pedicel (P14134) x 2.
Fig. 20 Gymnospermous seed (P14135) x 1·5.
Fig. 21 Gymnospermous seeds from Leigh Creek (P14136) x 1.

Plate 4.

Fig. 22 *Psygmophyllum cf. etheridgei* (P14137) x 0·5.
Fig. 23 *Psygmophyllum cf. etheridgei* showing the torn apex of the lamina. (P14138) x 1.
Fig. 24 *Psygmophyllum cf. etheridgei* (P14139) x 0·75.
Fig. 25 *Taeniopteris cf. dunstani* (P14140) x 2.
Fig. 26 *Taeniopteris cf. dunstani* (P14141) x 2.
Fig. 27 *Taeniopteris spatulata* Hypotype (P14143) x 1.
Fig. 28 *Taeniopteris spatulata* Hypotype (P14142) x 1.
Fig. 29 *Taeniopteris spatulata* Hypotype (P14144) x 1.
Fig. 30 *Taeniopteris spatulata* Hypotype (P14145) x 0·5.